

Over the past decade, a number of national research and international aid organizations have begun exploring diverse methods to help developing countries build the research capacity to deal with their own environmental problems. *The World Health Report 2002: Reducing Risks, Promoting Healthy Life* lists malnutrition, infectious and vectorborne diseases, lack of access to safe drinking water, inadequate sanitation practices, acute respiratory diseases, injuries, poisonings, and exposure to toxic chemicals as being among the major contributors to morbidity and mortality in developing countries. “But limited access to resources, services, and health care are not the only challenges for the developing world,” says Terri Damstra, a scientist in the World Health Organization (WHO) International Programme on Chemical Safety (IPCS). “Some of the most significant inequities are in the research devoted to resolving the environmental problems of developing countries.”

A 1990 report by the Commission on Health Research for Development titled *Health Research: Essential Link to Equity in Development* points to a tendency for countries with research capabilities to address their own needs first. According to the report, 90% of the worldwide expenditure on health research and development is devoted to major health problems affecting less than 10% of the world’s population—primarily the people living in the wealthier nations that have the research capabilities,

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The Capacity to Change

Building Global Environmental Health Expertise

says Rachel Nugent, a program director of health and economic development for the NIH's John E. Fogarty International Center. While developed nations pursue treatments for obesity, depression, and the major afflictions affecting their own citizens, there has been little incentive for Western countries to invest in research on health threats specific to other regions of the world. "In the long run, the health and environmental needs of developing countries will be addressed in the most sustainable fashion when their own scientists find cures and prevention measures themselves, using approaches that are tailored to their own needs," says Sharon Hrynkow, deputy director of the Fogarty Center.

Hrynkow explains further: "When researchers . . . are involved in research in their own country, they build greater connections with policy makers. They are also more likely to find solutions to specific problems of that country." Findings in one country may not be applicable in another country. For example, she says, a disease development used in one country may not work elsewhere where malnutrition or other diseases are prevalent. As an example, she says, the meningococcal vaccine developed in the United States was developed for a different strain than is found in other countries.

The task of building scientific capacity for any nation is daunting, involving much more than training a handful of scientists and sending them back to their countries. Bob Watson, chief scientist of the World Bank, points out that the bank wants all of its projects to be "totally owned by the people," where projects are eventually taken over and operated by experts in the respective countries. But,

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he says, "Quite often, at the end of the day, [the hosting countries] don't know how to implement the projects."

Creative Strategies for Building Scientific Capacity

Joseph Graziano, associate dean for research at Columbia University's Mailman School of Public Health, recalls when he and a group of Columbia scientists first went to Bangladesh seeking a collaboration to study arsenic in drinking water. An older Bangladeshi scientist told the group, "We know you guys: You come here. You do your research. You write your papers. You get famous, and you leave us with nothing." To that, Graziano says, "One hopes to be different." Through a Fogarty research grant, Graziano plans to train scientists and engineers at Bangladeshi universities to deal with the country's environmental problems.

"Approaches to providing capacity building have come a long way from the past, where we would send someone in to give a lecture, then leave," says Ingvar Andersson, a senior freshwater advisor for the United Nations Development Programme (UNDP). "Most of the programs today attempt to identify and enhance the existing capabilities of a country or a region."

It's hard to pin down just how much environmental health capacity building is taking place globally. Records of foreign students studying science and technology in Western nations do not indicate how many are specifically studying environmental health sciences. The number of groups dedicated to building environmental science research capacity in the developing world is difficult to determine due to a lack of coordination between groups involved in this specialty, Damstra says, and further, says Graziano, to the fact that relatively few people are involved.

The European Union, Scandinavian countries, Canada, and the United States provide varying degrees of financial and institutional support for collaborative general research and training programs through national science foundations and nongovernmental organizations (NGOs). Other research capacity building organizations have emerged since the 1992 Earth Summit. One organization that began its efforts well before that event is the International Development Research Centre (IDRC), which is partially funded by the Canadian government. The IDRC helps developing world communities find solutions to social, economic, and environmental problems through research. And the Third World

Academy of Sciences in Trieste, Italy, supports capacity building in sub-Saharan Africa.

International development organizations, such as the UNDP and the Global Environment Facility, plus various NGOs, generally conduct a different level of capacity building, often providing training support to nonscientists and policy makers. "Development organizations are not research facilities; it's not their mission to facilitate research capacities," says Hrynkow. There are a number of international organizations, such as the UN Institute for

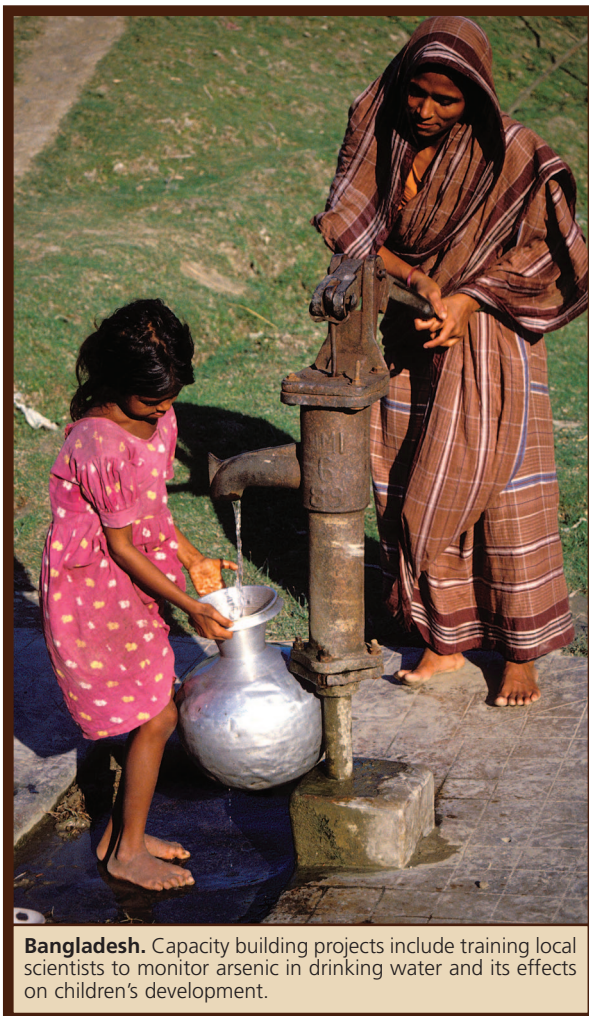
and Chinese government, NGO, and research communities to study environmental and energy problems in China. The Wilson center is also an information clearinghouse. "I've become a kind of matchmaker in helping [the] Chinese find partners to do their work," says Jennifer Turner, coordinator for the China Environment Forum. "A lot of our meetings have Chinese and Americans coming together to share what does and does not work."

Although most such collaborations are not funded for the purpose of capacity building in the developing country, they often serve as invaluable research building tools, according to Damstra. Trainees and visiting scientists can gain unlimited knowledge about research, institutional management, and communication between scientists and policy makers.

Other capacity building comes about in the routine pursuit of science. "I really do think that scientists and programs at universities motivated by pure intellectual interests often build capacity in the process of international research, not only through [dedicated] programs," says Chris Nielsen, executive director of the China Project of the Harvard University Center for the Environment. "Add these efforts up over all the research universities in the world and they might have one of the largest aggregate scientific capacity building effects, aside from citizens of less-developed countries simply getting educated in developed countries and returning home."

A similar capacity building effect takes place through scientific journals being translated into different languages or having an international focus. The American Medical Association publishes 28 international editions of the *Journal of the American Medical Association* and 19 international editions of its specialty journals. *EHP* now publishes a quarterly Chinese-language edition of news and research articles translated into simplified and traditional Chinese. *EHP*'s English-language version is also distributed in every country in the world. Similarly, journals such as *Science* and *Nature* are distributed worldwide and have offices around the world to facilitate international exchange of scientific information.

There is one nationally funded U.S. organization dedicated to raising environmental health research capacity in developing nations: the Fogarty Center, which provides training grants that permit U.S. investigators to train or collaborate with students and scientists in developing nations on health and environment issues. According to Joshua Rosenthal, deputy director of Fogarty's Division of International Training and



Bangladesh. Capacity building projects include training local scientists to monitor arsenic in drinking water and its effects on children's development.

Training and Research and the IPCS, that have research capacity building as an integral part of their mission. And the WHO has a broad global network of collaborating centers hosted in scientific and technical institutions to foster research capacity building.

One crucial part of capacity building is carried out when organizations team scientists from developed and developing nations to investigate specific environmental problems facing the developing country involved. For example, the China Environment Forum of the Woodrow Wilson International Center for Scholars links representatives from the U.S.

Research, an important feature of Fogarty programs is their use of collaborations, not “Westerners telling local people what to do.”

As a branch of the NIH, Fogarty grants are rigorously reviewed and predicated on supporting “best science” research. “Scientists need to know how to build good evidence bases that they can use to influence policy makers,” says Hrynkow. After completing a Fogarty program and returning home, foreign scientists may compete for grants from Fogarty’s Global Health Research Initiative Program and other major international research funding organizations. The Global Health Research Initiative Program offers up to \$50,000 a year for up to five years to support NIH-trained foreign investigators after they’ve returned to their home countries.

Collaborations between Developing Nations

A somewhat newer approach to scientific capacity building is the linking of institutions in less-developed countries with each other. Instead of providing conventional training for scientists, funding organizations identify the scientific capabilities of institutions in developing nations and link those that can help each other. “Neighbors share information and good practices and learn from each other instead of depending on institutions from [developed nations] coming down to tell them what to do,” says Andersson. “It’s less intimidating when countries at similar levels of development work together as equal partners.”

Andersson says the UNDP helps set up collaborations between developing countries according to the requests of the countries or region. In three different water programs, the UNDP used three very different approaches, tailored to the resources already in place in each country. In the first, in response to officials in Zimbabwe asking the UNDP for assistance with the country’s water projects, the agency helped create a regional network linking the University of Zimbabwe in Harare with Dar Es Salaam University in Tanzania. This provided the former with additional scientific training and curriculum materials for a master’s program in integrated water management (funded by the Netherlands). In the second, the UNDP linked scientists with policy makers in their respective countries when water engineers and scientists in Latin America identified their need for help in reaching policy makers. The agency organized a series of workshops to train scientists and engineers how to communicate with

policy makers, then held regional workshops and conferences to bring these players together. In the third, the UNDP is in the early stages of teaming institutions in Laos and Cambodia to share course materials and curricula on water management. Ultimately, the UNDP hopes to link the two countries with more developed neighbors that can help them further advance their water education programs.

Another group that adheres to a regional approach to research capacity building is the IPCS, which conducts regional training programs on the safe use of chemicals, methods for risk assessment, guidelines for conducting epidemiology studies, workshops for pediatri-

samples, or serve as a source for harmonized data collection activities or as a centralized source of information and education resources.

The IDRC has been working on building alliances between less-developed countries since 1970. In contrast with Fogarty programs—which focus on preparing trainees and scientists to produce “best science” research, often training at U.S. research facilities—many of the IDRC collaborations provide scientific activity, training scientists in their own countries. IDRC team leader Jean Lebel is most concerned about building collaborations between less-developed countries that “do not always have access to cutting-edge science to accomplish their goals.”

“Countries have to start somewhere,” adds Nugent. “At the earliest stages, they don’t need the most elaborate labs to be useful to the country. Even at a very basic level, their research may improve a country’s ability to deal with issues such as high infant mortality rates or agricultural procedures.” She says countries tend to move along a continuum, first relying on advice on how to do their work, then growing with various levels of labs and disciplines.

China as a Model

China provides an interesting model of a nation working proactively to improve its scientific capacity. China’s experiences point out the enormous challenge for any country to reach the level of scientific capacity needed to deal with its environmental problems.

Ever since 1978, China has been investing in building its scientific capacity as a means to improve the country’s economy, according to a 22 May 2003 article by David Zweig and Stanley Rosen posted online at the Science and Development Network. By the late 1980s, China was faced with massive environmental degradation too great to ignore; frequent disasters such as massive floods and food shortages were blamed on an array of environmental crises, from China’s widespread loss of forests and farmland to the ruinous conditions of the country’s air and water.

China ultimately added subdisciplines in environmental health sciences to the group of sciences to be mastered. At home, China also focused on building its scientific infrastructure to support advances in the sciences and engineering (including modest support for environmental health sciences), with many modeled on Western institutions, academies, and government services. China continues to send students and scientists to train in Western universities and welcomes significant collaborations with Western scientists.



Uganda. With support from the Third World Academy of Sciences and the Howard Hughes Medical Institute, scientists at Makerere University in Kampala are being trained in state-of-the-art molecular techniques to diagnose and treat river blindness and other maladies of the developing world.

cians, and other topics. The IPCS has also set up a network of poison control centers in developing countries to respond to a broad range of chemical safety issues, such as how to test for lead poisoning, with coverage of everything from symptoms, to prevention, to education.

Recently the IPCS has focused on environmental threats to children, particularly in the developing world. An international conference and workshops in Bangkok during the last few years have involved scientists and pediatricians from throughout Southeast Asia and have generated a number of collaborative research activities—such as monitoring levels and effects of arsenic in young children, and assessing childhood asthma in children using harmonized protocols—among scientists in that region.

Also in Southeast Asia, as well as other regions, the WHO is setting up regional centers of excellence staffed by local experts to deal with specific environmental health issues. Different centers could have different expertise. For example, some centers can develop and implement cooperative multidisciplinary research studies, provide a focal point for analysis of biological

Today, China sits next to Mexico and India as a country further along the continuum of developing capabilities in environmental health sciences. Articles by Chinese scientists appear in international peer-reviewed publications (China rewards its scientists for producing internationally competitive research through incentives such as cash awards and job opportunities). And Chinese scientists are taking a greater role in running many of the domestic environmental projects previously run by outside contractors or aid organizations, adds Jostein Nygard, coeditor of the 2001 World Bank report *China: Air, Land, and Water*.

But training scientists in Western universities and labeling institutions as “environmental health sciences” does not guarantee that China has instant expertise in that field, says Xiping Xu, an associate professor of occupational epidemiology and of medicine at Harvard and an adjunct professor at Anhui Medical University in China. In addition to political problems in China’s scientific and medical institutions, Xu points to two serious weaknesses that need to be addressed: inadequacies in how scientists are trained in environmental health sciences, and a lack of communication between the diverse scientific subdisciplines involved in researching any environmental problem.

Xu says Chinese scientists “think of science as mastering a skill or a set of methods rather than understanding interrelationships. . . . For example, in the globalization of disease, disease models are no longer simple cause-and-effect models. China needs to train scientists with knowledge, experience in interdisciplinary practices, and in leadership to think with vision.” China’s difficulties in dealing with the 2002–2003 outbreak of severe acute respiratory syndrome is viewed by many scientists as a reflection of some of China’s problems in the health sciences as well as its overall infrastructure.

Barriers and Brain Drain

Environmental research demands diverse training; scientists need to gain skills and experience in the multiple areas associated with their fields, and the ability to see the big picture of environmental problems. “Over time, we have discovered that scientists and engineers in most countries don’t know how to work together to share data,” says Nugent. “Often, health agencies gather only health data, and engineering agencies only deal with engineering data. In the case of health issues such as air pollution, the two agencies do not know how to work together to identify the

health effects of varying levels of air pollution.” The infrastructure for bringing them together doesn’t exist, says Nugent, but part of capacity building is exploring ways to help scientists and administrators make the links.

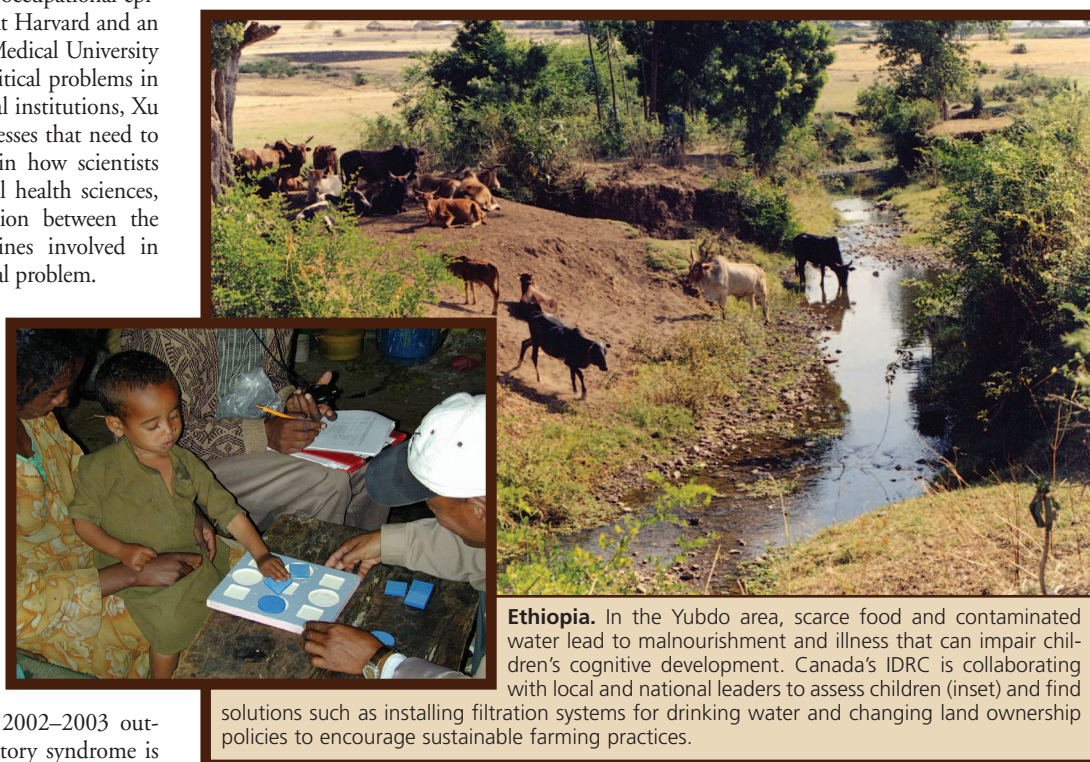
Equally important, says Christopher Schonwalder, director of international programs and public health at the NIEHS, is that many scientists in foreign countries lack the training in critical and hypothesis-posing thought needed for many grant proposals, as well as for good science itself.

“It has to be a labor of love, this research capacity building,” says John Froines, a professor of environmental health sciences at the University of California, Los Angeles. “There is nothing easy about it, and there are always barriers to get through.” Froines has been working

scientists in developing countries can find out basics such as where to get help or how to seek out collaborations, connect with training programs, obtain equipment, or apply for grants.

Scientists in more developed countries, such as Mexico, face a very different set of challenges. “You have some highly trained scientists in Mexico, yet there are enormous needs,” says Froines. “In the United States we have trained thousands of occupational hygienists through the Occupational Safety and Health Administration at the masters’ and doctoral level. There still isn’t any graduate degree program in that area in Mexico. You can have some strong scientists, but lack training for people who work with them.”

Getting trainees to return to their home countries once training is completed is a



Ethiopia. In the Yubdo area, scarce food and contaminated water lead to malnourishment and illness that can impair children's cognitive development. Canada's IDRC is collaborating with local and national leaders to assess children (inset) and find solutions such as installing filtration systems for drinking water and changing land ownership policies to encourage sustainable farming practices.

in Mexico since 1990, focusing on environmental and occupational health problems.

Some of the most common barriers include problems of poor institutional infrastructure, governmental and institutional corruption, and weak collaborations between institutions. “If you want long-term research collaborations as a basis for building research capacities, you have to start at the ground level of building researcher-to-researcher connections,” says Damstra. Unfortunately, she says, international aid organizations often work through the ministry of each country. Many administrators are not researchers and may not be aware of the needs of the researchers in their respective countries. Furthermore, she says, there isn’t any centralized or regional information system where

problem for all science programs. “Trainees become accustomed to good salaries and easier work conditions than they will have at home,” says Rosenthal. “We know from other programs that the longer trainees stay in the host country, the more likely they are to accept permanent jobs there.” This results in so-called brain drain.

As an example, 821 out of 951 Chinese students who received their doctorates in Earth, atmospheric, or ocean sciences in the United States between 1988 and 2000 planned to stay in the United States. Of the 821 staying, 34.7% had offers for postdoctoral training, and 20% had firm job offers in the United States, according to the Division of Science Resources Statistics of the National Science Foundation.

A variety of strategies are used to entice trainees to return home and stay there. China has shifted its policies to address brain drain, and collaborating programs are doing their part to limit the chance they will contribute to the problem. As a result, many overseas traineeships have been reduced to 6–12 months, says Nielsen. “We’re also trying to promote ongoing collaboration with, and thus research funding for, those who do return,” he adds.

“Brain flight,” on the other hand, describes trainees who return to their home countries, then leave again because the country can’t support research for some reason. Brain flight is most common in the least-developed nations, which lack scientific institutions or infrastructure to support research and its connections to policy making.

Certain Fogarty programs include safeguards to ensure that scientists will have jobs and research support after they complete the grant. Fogarty also requires trainees to get a letter of support from their home institution, stating that the trainee will have a relevant job to return to with a lab to work in, and to demonstrate that they have links to existing internationally funded research with continuing research investments.

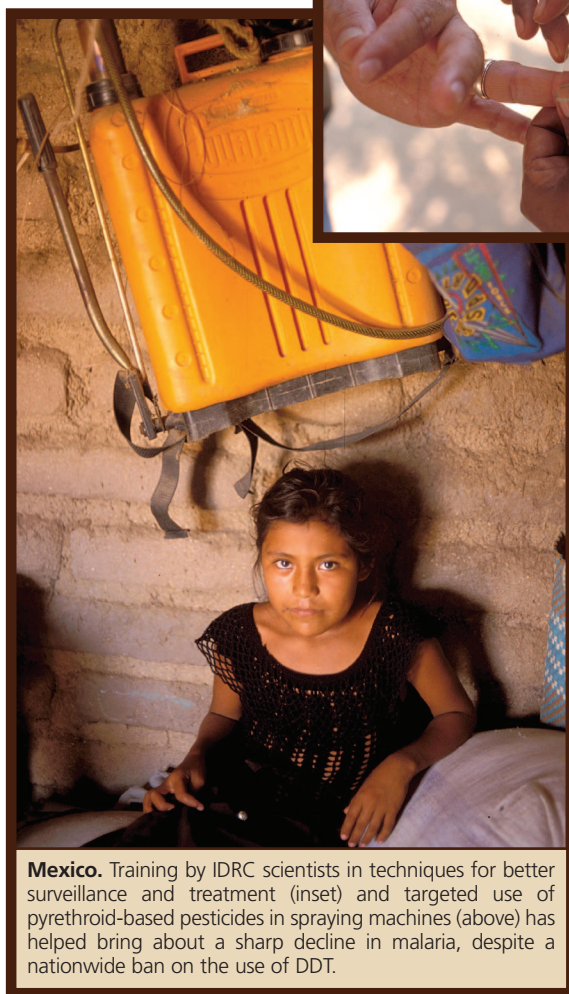
Another important advance in capacity building is the emergence of programs and workshops to address weaknesses in the institutions the scientists work in. There are many horror stories about institutional problems that create barriers to research, such as institutions that place newly trained scientists in jobs where they can’t use their skills, and universities that don’t know how to manage grant money. “There is often a huge gap between scientists and policy makers,” says Lebel. “Often policy makers don’t know what they can and cannot expect from science. And administrators don’t know how to set up the financial and other agreements that make grant applications possible for their scientists.”

Several organizations, including the NIH, the WHO, the UNDP, and the IDRC, offer grant-writing workshops and institutional management courses for scientists and administrators alike. Many of these groups bring scientists and policy makers together to forge patterns of improved communication. Others offer workshops on how to write and administer grants and write a hypothesis-based grant application. China, as one country that has

identified the need to improve the skills of its administrators, now routinely sends its deputy directors to study management at The University of Wisconsin and other Western universities.

Assessing the Results

Evaluating the outcome of capacity building is difficult, certainly more complex than just measuring the number and quality of publications and the movement into leadership. Ideally, Fogarty directors would like to see a cadre of scientists who can be equal partners



Mexico. Training by IDRC scientists in techniques for better surveillance and treatment (inset) and targeted use of pyrethroid-based pesticides in spraying machines (above) has helped bring about a sharp decline in malaria, despite a nationwide ban on the use of DDT.

with their U.S. colleagues and compete for grants from government agencies in Europe and North America. “But how can you compare the advances of scientists from least-developed countries who are only starting to build courses and infrastructure against those who are publishing research articles in competitive journals?” Nugent asks. “And how can you compare programs with very different expectations?”

The scientific capabilities of China, India, and Mexico are vastly greater than those of most other developing nations, but these three

nations still face some of the world’s most serious environmental health problems. “There is evidence that research is producing results where the information is applied,” says Hrynkow, “yet the tide of environmental problems coming up is rising so fast that it obscures most successes.”

Damstra says it may be most important to look at the long-term benefits of research capacity building. Collaborations, she says, do not necessarily require huge amounts of funding, but they do require persistence and a willingness to devote personal time and energy. Once initiated, collaborations are often long-term; Damstra describes running into scientists from all over the world who still collaborate with Western scientists on projects begun 20 years ago. “Although it is difficult to evaluate the impact of such collaborations objectively,” she says,

“there is no doubt in my mind that some of these informal collaborations lead to very successful capacity building.” Yet, without any research demonstrating that investing in health and the environment helps economic development, it is difficult to convince developing nations to place a priority on building scientific capacity in this field, says Nugent. That trend may be reversing, however. The first report demonstrating the economic benefits of investing in health sciences, the WHO’s *Macroeconomics and Health: Investing in Health for Economic Development*, came out in 2001.

If there is an economic gain to investing in the environment and health, Fogarty hopes to provide some measurement. A new Fogarty program called Health, Environment, and Economic Development (HEED) will fund research that explores the effects of scientific capacity building on topics combining issues of health, environment, and economic development. Nugent hopes that HEED reports will provide the evidence needed by policy makers to address environmental problems that affect the health and well-being of their people.

Even without firm proof of economic benefits, Damstra, Lebel, and other scientists contend that developing nations need to place a high priority on developing their scientific capabilities in the environmental health sciences. People in developing countries face many environmental problems specific to their region. “Who will research the problems and carry the solutions to the communities to make changes if the people in those communities are not involved from the start?” asks Lebel.

Corliss Karasov